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EQUIPMENT

ARRESTING SYSTEMS

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ATG02

FOREWORD

PURPOSE: This publication is for use in the training of USAF air traffic controllers and is not intended to replace, substitute for, or supersede official regulations, procedures, or directives.

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TERMS RELATING TO AIRCRAFT ARRESTING SYSTEMS

The unique terms used in this manual as well as the referenced documents are described below.

Aircraft Arresting System (AAS): A series of components used to engage an aircraft and absorb the forward momentum of an emergency landing or an aborted take off.

Arresting Barrier: A device, not dependent on an aircraft hook, used to engage an aircraft and absorb the forward momentum of an emergency landing or an aborted take off.

Aircraft Arresting Cable: That part of an aircraft arresting gear which spans the runway surface or flight deck landing area and is engaged by the aircraft arresting hook. This component is also commonly referred to as the pendant, hook cable, cable or wire.

Aircraft Arresting Complex: An airfield layout comprised of one or more arresting systems.

Arrestment Capable Aircraft: An aircraft which has arrestment procedures published in its flight manual.

Cycle Time: A measure of the time between the engagement of an aircraft and the point at which the arresting system is capable of another engagement. Systems will not be considered back in service until declared so by the cognizant maintenance activity.

Emergency Arresting System (EAS): An arresting system normally installed in the overrun area of the runway which is used to prevent loss of life and damage to aircraft during an aborted take-off or landing.

Energy Absorber: The component of the arresting system through which the kinetic energy of the arrested aircraft is dissipated.

Location Identification: The location of an arresting system within the arresting system complex is identified by stating whether it is located on the approach or departure end of any particular runway designation and its position described in hundreds of feet with respect to the threshold. E.G. Extended runout BAK-l 2 at + 1,300 on approach runway 36. This indicates the 1 ,200 foot runout BAK-I 2 is located 1,500 feet beyond the threshold of runway 30.

Operational Arresting System (OAS): A rapid cycle, bidirectional arresting system designed for use on a daily basis to enhance the tactical mission and avert emergencies created by meteorological conditions. snort or slick runways and known or suspected aircraft malfunctions.

Reset Time: The time required to ready the arresting system for another engagement niter aircraft release. (This does not include the time required to disengage the aircraft from the AAS.)

NOTE: This manual was created using excerpts from AFI 32-5005. For more detailed information on barrier systems and operations, refer to the appropriate Manuals and Technical Orders references in this test.

TYPES, AND COMPONENTS OF ARRESTING SYSTEMS

1. Aircraft arresting systems consist of engaging devices and energy absorbers. Engaging devices are net barriers, disc supported pendants (hook cables, and cable support systems which allow the pendant to be raised to the battery position or retracted below the runway surface. Energy absorbing devices are ships anchor chains, rotary friction brakes such as the BAK-9 and BAK-l 2 or rotary/hydraulic systems such as the BAK-l3 and E-28. There is no connection between the USAF designations of these systems and their function. The systems designated "Barrier, Arresting Kit" (BAK) are numbered in the sequence of procurement of the system design. Other designations such as E-5, E-28 and M-21 are US Navy designations. The systems in use within USAF today are depicted in figures 1 through 8 at attachment 1, and described in the following paragraphs.

2. MA-1A. The MA-1A (figures 1 & 2) is an emergency arresting system comprised of a net barrier and cable system designed to engage the main landing gear of an aircraft. It is a unidirectional system which dictates that it always be installed in the overrun area. These systems require a minimum of 850 feet plus the length of the aircraft of runout area. It should be noted that aircraft engaging this system above the speed and weight limits provided within figure 2-2 of T.0. 35E8-2-1-101 will result in a runout greater than 1,000 feet or cable failure. Most MA-lA systems employ ships anchor chains laid out on either side of the runway in the direction of aircraft travel, as the energy absorber. However, some MA-lA nets have been configured with a BAK-9 as the energy absorbing device. These are designated MA-1A/BAK-9. Either configuration may be equipped within disc supported pendant (hook engaging cable), interconnected with the net system and energy absorbing device. This cable is positioned on the runway side of the net to allow tailhook engagements. This configuration is designated MA-1A Modified. The MA-1A is no longer available for procurement and therefore can not be considered for new installations unless salvaged from another installation. Further technical information on this system can be obtained from USAF Technical Manual (T.O.) 35E8-2-2-1, USAF Types MA-l and MA-1A Runway Overrun Barrier.

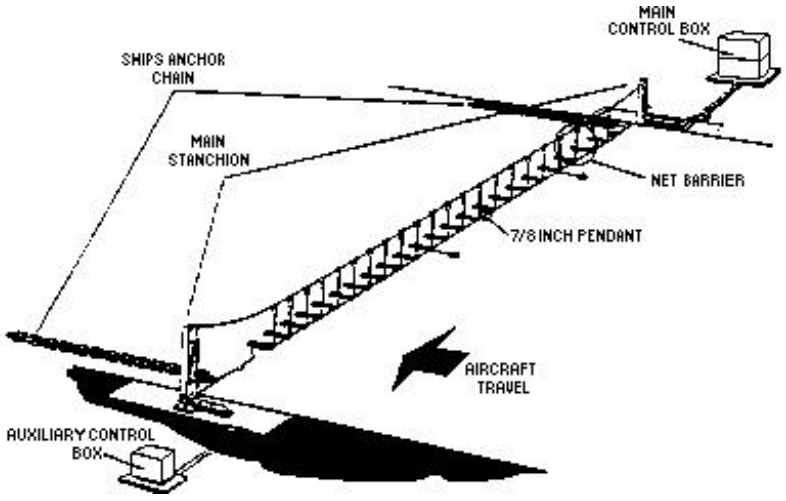

Figure 1, Runway Overrun Barrier Type MA-1A

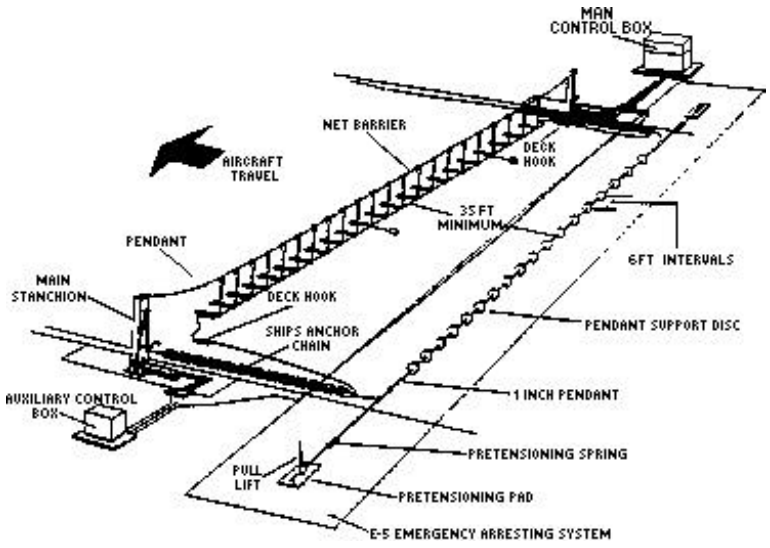

Figure 2, Runway Overrun Barrier Type MA-1A Modified

3. E-5. (Figure 3) This unidirectional emergency arresting system is a US Navy design and designation. Much like the MA-1A, this system employs several shots of snips anchor chain as the energy absorber. These systems are configured with from one to four disc supported hook cables, with designations of E-5, and E-5 Mod 1 through E-5 Mod 3. However, these systems never employ a barrier (net) of any type. Further technical information on this system can be obtained from US Now Publication NAVAIR 51-5-28.

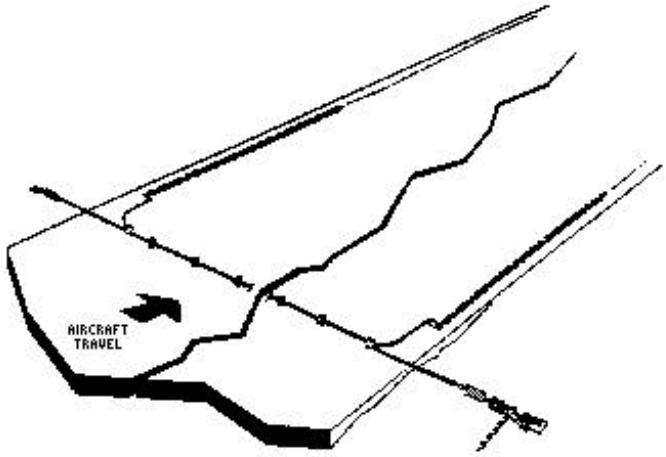

Figure 3, E-5 Emergency Chain Arresting Gear here

4. BAK-9. The BAK-9 (Figure 4) is a bidirectional emergency arresting system. It is comprised of only one energy absorber which employs two rotary friction brakes and purchase tape reels mounted on a common shaft. The reels are mechanically connected at the mid-point by a third brake which acts as a clutch. This allows each reel to turn at different speeds during off-center engagements, and helps steer the aircraft toward the center of the runway. The energy absorber must be installed below grade on one side of the runway with the necessary deflector sheaves and duct to route one of the purchase tapes to the opposite side of the runway so it may be connected to the disc supported pendant. The other tape must be routed to a turn-around sheave located in a pit which is sited to allow both purchase tapes to be of equal length. The BAK-9 is no longer available for procurement and therefore can not be considered for new installations unless salvaged from another installation. Further technical information an this system can be obtained from Technical Manual (T.0.) 35E8-2-4-l, .Aircraft Arresting Gear, Model BAK-9

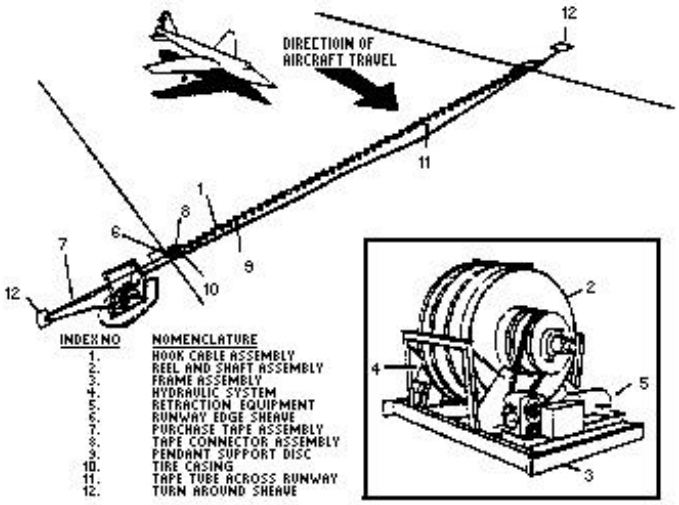

Figure 4, BAK-9 Aircraft Arresting System

5. BAK-12. The BAK-12 (Figure 5) is the standard USAF operational aircraft arresting system. This bidirectional system employs two energy absorbers, each of which is equipped with two multi-disc rotary friction brakes mounted on either side of the purchase tape reel on a common shaft. The energy absorbers are installed on opposite sides of the runway and connected by the purchase tape to a 1.25 inch disc supported pendant. The installation should be, preferably in a below grade pit with a minimum split distance of 50 feet between the lend-on sheave of the fairlead beam or deck sheave, and the energy absorber. Split distances of up to 300 feet are acceptable for all BAK-12 installations. BAK-12 systems may also be installed above grade in one of two separate configurations, depending upon site conditions and operational requirements. These are referred to as the expeditionary installation and the semi-permanent installation. Siting and grading requirements are presented within Section 3 of USAF. Technical Manual (T.0.) 35E8-2-5-1. Drawings for pit type installations (drawing number 67F2012, and Semi-Permanent installations (drawing number 67F2011) are available from the San Antonio Air Logistics Canter (SA-ALC).

An expeditionary installation can be accomplished in approximately 100 manhours; however, anchoring for this installation is accomplished by connecting the energy absorber to buried "dead man" anchors via chains and other associated hardware. This type installation may not continue in service for more than one

unless the anchors are excavated and inspected. These type installations are typically accomplished to accommodate temporary requirements such as exercises and during periods of construction. Sitting requirements and installation instructions are presented within Section 3 of USAF Technical Manual (T.0.) 35E8-2-5-1.

Semi-permanent installations are accomplished on grade in cases where pit installations are not economically feasible. In these instances, the energy absorber and purchase tape must be protected from the elements by means of a frameless metal structure with a removable roof and/or end, and fairlead tubing. The energy absorber foundations must be sited at least 200 feet from the runway edge.

BAK-l 2 energy absorbers were originally equipped with a 60 inch diameter purchase tape storage reel. This design allowed dissipation of the maximum energy expected to be imparted during an aircraft engagement within a runout of 950 feet plus the length of the aircraft. Since inception, the BAK-12 design has been upgraded and improved to meet increased demands of heavier and faster aircraft. This was accomplished in part by retrofit of the energy absorbers with larger 66 inch or 70 inch tape storage reels to accommodate increased runout, thus increasing the total energy capacity of the system. Although some systems may still yet be configured with 60 inch tape storage reels, all new systems procured by USAF as standard BAK-l 2 systems (part numbers 52-W-2291-801A, 52W-W-2291-901 and 52-W-2291-901A) are equipped with 66 inch reels. These systems require 1,200 feet plus the length of the aircraft for maximum runout. The 72 inch reel systems are special purpose systems configured for 2,000 feet runout.

The standard BAK-l 2 is configured for cross runway separations of up to 200 feet (distance between fairlead beams or deck sheaves). Installations with cross runway spans exceeding 200 feet require that the BAK-l 2 control valve cam be replaced to accommodate full runout of the system. Refer to T.0. 35E8-2-5-1 and 35E8-2-5-4 for the correct replacement cam part number and installation procedures.

Dual BAK -12 systems are special purpose installations configured to accommodate high energy engagements of aircraft ranging from 60,000 to 140,000 pounds. These configurations consist of four BAK-12 energy absorbers arranged in pairs on either side of the runway with a 1.25 inch disc supported pendant. The energy absorbers may be standard BAK-12s or equipped with 72 inch diameter tape storage reels to accommodate 2000 feet of runout. Special tape connectors and ease sheaves are required for these installations. These components and other special considerations are discussed in detail within section VIII of T.0. 35E8-2-5-1.

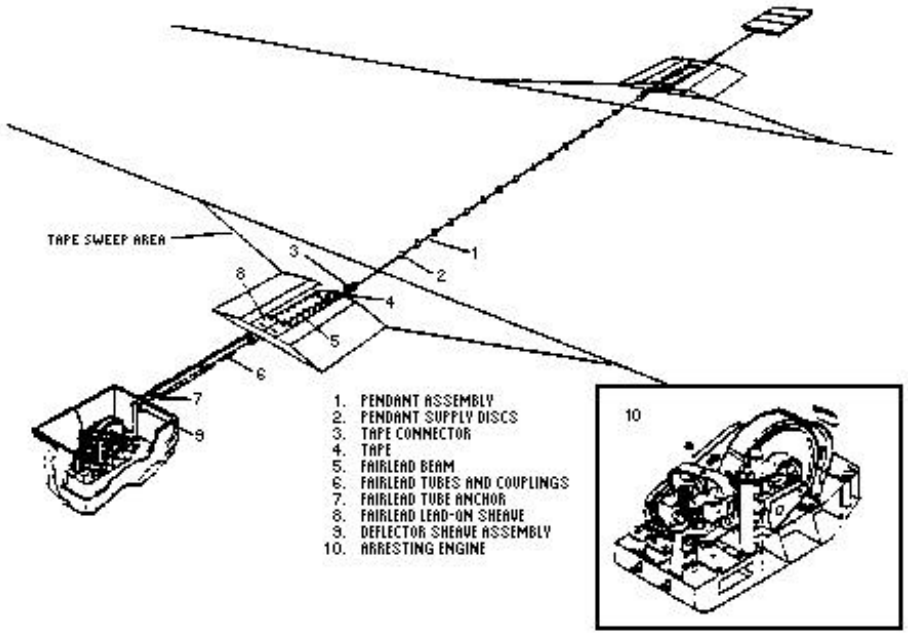

Figure 5, BAK-12 Permanent Installation (With Fairleads)

6. BAK-13. The BAK-13 (Figure 6) is a bidirectional, operational aircraft arresting system. It employs two velocity sensitive energy absorbers installed on opposite sides of the runway, interconnected by nylon purchase tapes and a 1.25 inch disc supported pendant. The energy absorbers are comprised of a steel weldment base which incorporates a tape storage reel mounted on a vertical shaft with a vaned rotor assembly enclosed within a vaned strator assembly (also called a tub), which is filled with a water/glycol mixture. An operator control panel, rewind engine and transmission assembly as well as the associated hydraulic system components are also integral to the energy absorber. The energy imparted during an aircraft arrestment is converted to heat through the turbulence developed by rotation of the vaned rotor within the vaned strator. An external cooling reservoir is provided for rapid cycle of this system. BAK-l 3 systems are installed on grade in one of two separate configurations, depending upon site conditions and operational requirements. These are referred to as the BAK-12 except when installed in a semi-permanent installation. Siting and grading requirements are presented within Section 3 of USAF Technical Manual (T.0.) 35E8-2-7-11. These requirements are essentially the same as for the BAK-12 except that when installed in a semi-permanent configuration, the low profile units may be located as close as 150 feet to the runway edge. These systems require 900 feet plus the length of the aircraft for maximum runout.

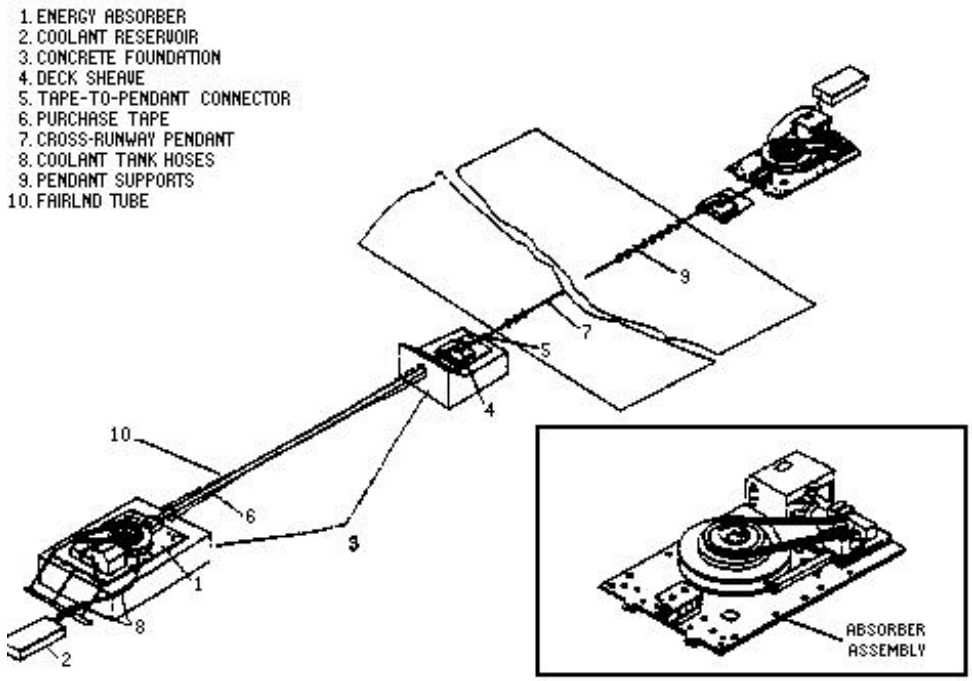

Figure 6, BAK-12 Aircraft Arresting System (Semi-Permanent Installation)

7. BAK-14. (Figure 7) This system is a bidirectional hook cable (pendant) support system used in conjunction with the BAK-12, BAK-13 or other comparable arresting system, to engage and safely stop a hook equipped aircraft. It provides a means of supporting the pendant a minimum or two inches above the runway surface while providing Air Traffic Control a means of lowering the pendant below the surface of the runway to prevent damage to low undercarriage aircraft, the pendant, and the pavement below the pendant, during trampling. The system is comprised of individual pendant support arms and their housings (support boxes), cross runway cable containment trough, the pneumatic line, heaters and controls and the compressed air system. The BAK-l 2 pit or protective shelter must be expanded to house the compressed air, and control systems. These systems can be procured to accommodate runways 150, 200 and 300 feet wide. Detailed site and utility considerations are provided within USAF Technical Manual (T.0. 35E8-2-8-1, Operation, Maintenance and Installation Instructions With Illustrated Parts Breakdown. Hook Cable Support System, Model BAK-14.

It should be noted that the engagement success rate for this system is lower than that of systems employing a disc supported pendant. In light of this, USAF has found that installation of pendant restraints at select locations across the runway serve to reduce cable slap to aircraft during trampling. Refer to T.0. 35E8-2-1-101 for standard detail drawings of these anchors, their recommended locations, and specifications for the materials and procedures to be employed for their use.

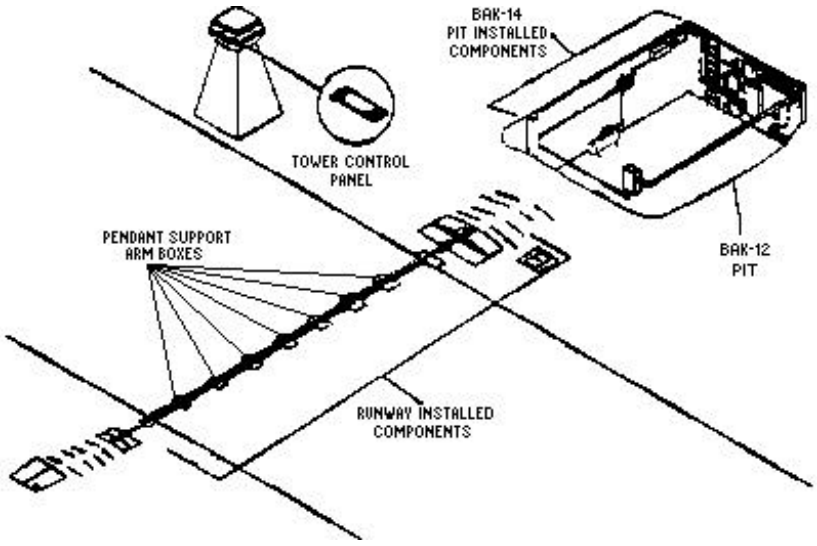

Figure 7, BAK-14 Hook Cable Support System

8. 61QSII. The 61QSII (Figure 8) emergency aircraft arresting system is designed to provide support and remote controlled movement for a unidirectional nylon net barrier. It consists of n pair of electrohydrolic steel masts installed on opposite sides of the runway overrun on concrete foundations, and a remote control panel in the air traffic control tower. The remote function may be accomplished through hard wired or radio control. This system must be augmented with an energy absorbing device such as a ships anchor chain, BAK-9, BAK-12, BAK-13 or other comparable equipment which is connected via the purchase tape to the ends of the lower net straps. During an aircraft engagement, shear links in the net suspension straps are separated by the force of the aircraft engaging the net. The net then envelops the aircraft and seats on the leading edge of the wings, transferring the forward momentum of the aircraft to the energy absorbing device. The system may be complemented with a standard disc supported pendant to accommodate tailhook engagements through interconnect configuration hardware similar to that used for the MA-1A Modified. The hook cable interconnect hit is known as the 62 NI (net interconnect). System operation and maintenance instructions are contained within USAF Technical Manual (T.0. 35E8-2-9-2 Installation drawings must be obtained through the procuring activity at the time of procurement.

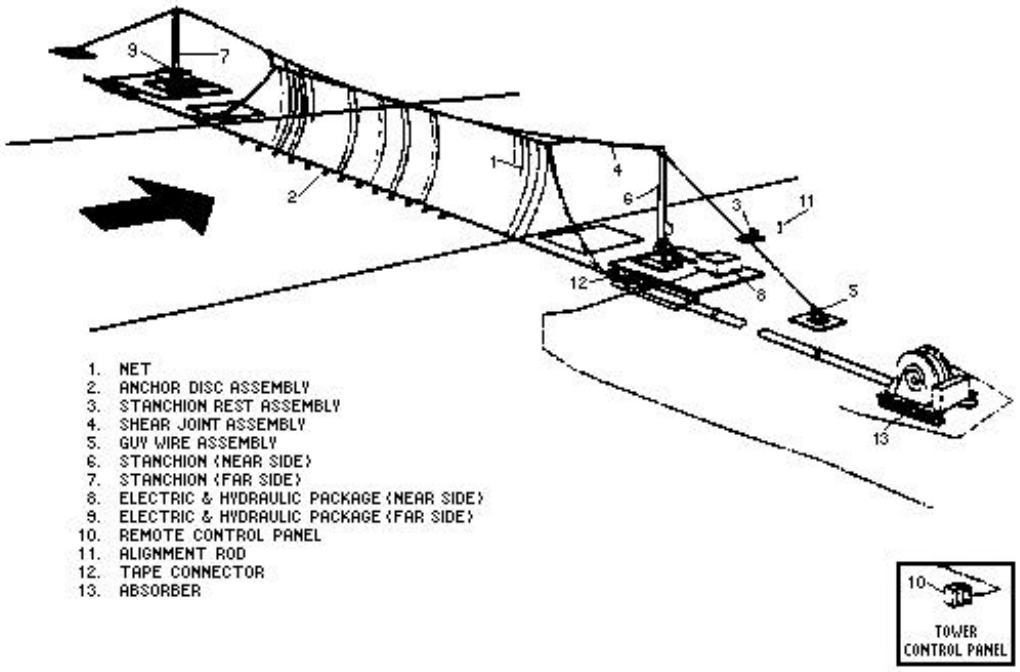

Figure 8, 61 QSII Quick Erect Stanchion System with Bak-12 Energy Absorber